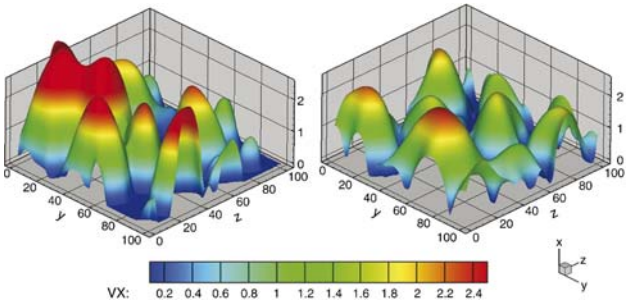

Fig. 1 Profiles of velocity (VX), normalized by its respective value at the entry. These slices, which are taken at different levels of the bone, show the nonuniformities in the flow profile.

on validated Lattice Boltzmann code, which has been previously used to study Newtonian flow in packing of glass beads. The 3D trabecular bone skeleton was reconstructed using the microscans. The simulation was conducted for a small Reynolds number of 0.0 to 1, which is characteristic for the flow process of this medical procedure.

Results: Trabecular bone showed a well-organized 3-D structure and a very high porosity. In the case of healthy bone, its porosity is in the range of 80% but increases up to 96% for bone suffering from osteoporosis. Fig. 1 shows the velocity profile within the cavities of osteoporotic bone. It shows that the velocity and volume flow rate vary substantially depending on the size of the cavity and, more importantly and very substantially, because of the nonuniform cavity structure and distribution throughout the sample.

Discussion: This study presented a microscale flow model of Newtonian flow through the trabecular bone cavities. Micro CT scanning provides representative geometric data and, if combined with the simulation, both seem to be adequate to address the question posed. Future directions will examine geometrically larger models and physically more adequate non-Newtonian models of the fluid, in addition to understanding the local velocities, flow patterns and pressure drop in the bone cavities. This research may provide understanding on the role of the length scale in passing from the pore scale phenomenon to the macroscopic scale, which will likely make the computation more efficient in the long run.

doi:10.1016/j.mri.2007.01.023

AxCaliber: an MRI method to measure the diameter distribution and density of axons in neuronal tissue

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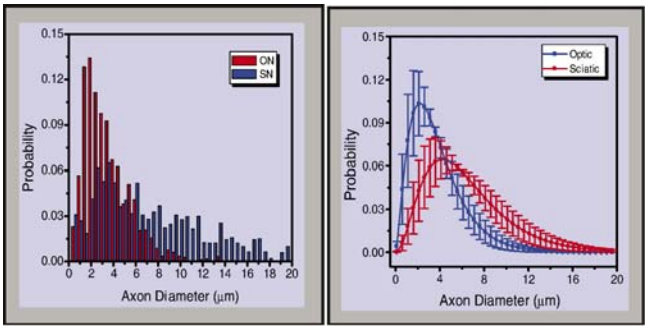
The experimental determination of the diameter distribution, $p(d)$, of emulsions and droplets has long been studied using NMR methods (see Refs. [1,2]). In these experiments, $p(d)$ is estimated from PFG data by assuming a model of restricted diffusion within spheres. We have adapted this approach to estimate the diameter distribution within cylindrical nerve fascicles — a pack or array of nerve axons — by assuming that axons contain a restricted pool of water within their intracellular spaces. A composite hindered and restricted model of diffusion (CHARMED) within axons was first elaborated and tested in Ref. [3], and then applied clinically in Ref. [4].

The *AxCaliber* framework presented here extends CHARMED by providing an estimate of $p(d)$ directly from diffusion-weighted (DW) MR data. In this implementation, a *Gamma* distribution is assumed to describe the axon diameter distribution. Parameters of this distribution are then estimated from the PFG data in optic nerve (ON) and sciatic nerve (SN) bundles. The estimated $p(d)$ using *AxCaliber* (above right) is compared with measurements obtained from histological analysis (above left).

MR experiments were performed using a 7-T scanner (Bruker, Germany) on fixed porcine nerve tissue. High b-value DWIs were acquired with a



stimulated echo DWI sequence with the following parameters: TR/TE=3000/166 ms, δ=2.5 ms, G_{max}=120 G/cm, no. of averages=8, with the diffusion time, Δ, chosen from 20 to 150 ms in eight increments. Diffusion gradients were applied only perpendicular to the nerves' axes in 16 gradient amplitude increments for each Δ. The entire acquisition consisted of 128 DW spectra acquired in 51 min. Histological analysis was performed using conventional myelin basic protein (MBP) stains along with particle sizing software used on the histological sections.

Agreement between MR and histology data is excellent, suggesting the possibility for measuring $p(d)$ in vivo using DW-MRI data.

The marriage between MRI and porous media theory with biology and medicine is generating promising new applications. *AxCaliber* is one such example of a growing discipline of *virtual in vivo tissue biopsy*.

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doi:10.1016/j.mri.2007.01.024

Two-phase flow in a flexible porous medium

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Flow in porous media composed of rigid materials or arrays of rigid components, such as porous rock or packed beds, is now studied routinely using MR [1,2]. Acquisition schemes have been developed that achieve high spatial and/or temporal resolution and which further lend themselves to the study of flexible porous media, which may be deformed by the application of flow. The deformations may be temporally stable or unstable, and examples of these porous media are filtration materials, hollow-fibre bioreactors, and fibres presented as arrays used in the textile industry. Here, we report on the characteristics of two-phase flow in a flexible porous medium constructed from parallel fibres anchored in a cylinder.

The aim was to map flow for different densities of fibres, in order to assess the ability of the medium to alter its porosity, trap the liquid phase and alter flow properties of the liquid phase.